South-South Cooperation: The Case of Farmers' Water User Associations For Rural Reform In China

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Abstract

One major component of China's rural reform strategy has been in the field of irrigation management. This strategy, pronounced in terms of institutionally rebuilding farmer's irrigation water association for more equitable, efficient, and peaceful water use, was a model of South-South learning and cooperation. The strategy was adapted to the Chinese context and needs. This strategy not only helped to democratize farmers' participation in irrigation management but also based farmers' water user associations on hydrologic boundary. For the first time this strategy was implemented in 1995 as a pilot exercise in the 3rd Main Canal Service Area of Jingmen city of China's Hubei Province. The implementation was carried out by a team of Nepali professionals under the World Bank - funded Yangtze River Water Resources Development Project. The Nepali team worked in partnership with the local leading group, consisting of all relevant government organizations. By 2009, some 50,000 farmers' water user associations (WUAS) were formed and are now in operation in about one-third of the irrigated area of China. The Project completion assessment has shown farmers' satisfaction with the institutional reform in the local irrigation management and reported benefits in terms of ownership, reduction in water-related conflicts, reliable and equitable irrigation deliveries, increased agricultural productivity, and more effective use of local government resources. The presence of such an institutional base in the form of WUA has enabled the farmers to cooperatively manage the challenges emerging and the concerns related to irrigated agriculture.

1. Introduction

Agriculture is the most basic sector of China`s National economy. Of the Gross Domestic Product (GDP) of USD 4,985,461 million, agriculture accounted for around 10 percent[2]. Twenty years ago, it accounted for 25 percent. Of the economically active population (EAP) of about 804 million, the agriculture sector employed 499 million (62%) people.

China's per capita freshwater availability is 2,111 m^3 whereas the global average is 6,466 m^3 per capita. Agriculture is the main water withdrawal sector,

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[2] http://www.fao.org/nr/water/aquastat/main/index.stm.2011. FAO's Information System on Water and Agriculture., China.

but only 45 percent is actually consumed by crops, due to low efficiency in irrigation systems. This figure is comparatively high, considering the cropping structure. The relatively poor water productivity in the country, USD 3.6 per m^3, is lower than the average of USD 4.8 per m^3 in middle income countries.

Of the total area with irrigation in China of 62.6 million ha, 57.1 million ha (91.2%) were under food crops. A 2006 assessment report indicated that all the reported irrigated areas did not receive irrigation water service evenly. The figure on drought - stricken farmland every year has reached an average 15.3 million ha, nearly 13 percent of the total farming area.

Irrigation makes a major contribution to food security, helping an irrigated cropping intensity of 1.72. The major irrigated crop is rice, followed by wheat and maize. The average paddy rice yield of irrigated farmland was 7.3 tons/ha (about three times more than the non-irrigated one). In 2005, almost three-quarters of grain production came from irrigation. The importance of irrigated vegetables is also growing.

The United Nations predicts that China's population will increase from 1.2 billion to 1.5 billion between 2020 and 2030. To feed the increasing population, China has to increase the total agricultural products by almost 30 percent by 2030. The quantitative expansion of irrigation will be difficult as rapidly urbanizing population is expected to further push water demand to new heights. The expanding industrial sector is also greedy for water.

Operating the landholding scale of farmland and its expansion, institutionalizing the operation of market economic principles, and implementing irrigation management strategy to promote rural reform agenda with a focus on equity, efficiency, and social stability in the use of irrigation resources pose both challenge and opportunity. As far back as 1992, the government announced the goal of establishing a socialist market economy. Before the market economy, China had adopted a centrally planned economic system. In this system, the state determined production and pricing. In a market economy, however, consumer demand for goods and services determines production and pricing. The new market economy system with Chinese characteristics asks for rules and institutions that create a level playing field for the stakeholders.

As a matter of fact, the first reforms toward achieving the new national objective of modernization and richness had begun in poor rural areas in 1979, when the government replaced communal farming and distribution with the household contracting and responsibility system. Under this system, individual farm households worked separate plots of land owned by an economic collective. It households could sell produce at farmers' markets for whatever price buyers were willing to pay in return for selling a certain amount of produce to the

collective at a predetermined price. The contract and responsibility system was successful because it gave farmers an incentive to reduce production costs and increase productivity.

2. Irrigation Management Challenges and Scenario

Under these circumstances, the Chinese practice would be to proceed step by step and make a major breakthrough in institutional reform through a series of experiments. This would be achieved first by solving the easy ones, then the difficult problems, proceeding in an orderly way while losing no time to make the breakthroughs to push ahead institutional reform to achieve self-management. Macro-economically, market - guided reform measures of the economic system would be planned to meet the market economic system requirements. At the same time, it would also open the ground for the south-south and south-north learning and cooperation for changing the nation's socio-economy. In other words, micro-economically, the reform would change the institutional mechanism of irrigation system internally meeting the needs of development of the socialist market economy.

The foregoing introduction suggests that irrigation management in China needs to address and resolve the following challenges:

- Make the agricultural sector, where a larger majority of EAP are engaged, socially and economically more beneficial;
- Enhance more productive use of irrigation water, which is s getting scarce and thereby saving it more;
- Ensure food security;
- Assure weather uncertainty triggered by climate change;
- Ensure orderly transition of farming community from a centrally planned economy to socialist market economy;
- Link rural development and reform to a national modernization framework.

2.1 Irrigation Sector Scenario

The situations prevailing in the irrigation sector were simply not able to address and resolve the challenges listed. The challenges were not only a reflection of China's centrally administered planning but also of opening up to the international community (like WTO). They also indicated China's standard approach in dealing with irrigation as only a technological one.

The existing irrigation and drainage management structure was based on administrative boundaries (i.e. village boundaries). The Village Committee (VC), the grassroots level organization, supported the higher local government unit

(township, county, prefecture or municipality) which had the authority for the construction and maintenance of irrigation, drainage canal, and pump stations. A public utility or local government's water resources bureau at the township, county, prefecture or municipal level had the authority to collect water charge and operate the irrigation, drainage system including the pump stations. The VC was responsible for irrigation and drainage operation. In such a system, irrigation system management was dispersed among different levels of government administration, rather than consolidated in a more efficient hydrologic unit.

Irrigation water was priced below cost, or not charged at all. As a result, each irrigation system had started to become a historical burden on government administration, which lacked funds for the operation and maintenance (OandM). "Gray water charges" were rampant in the sense that the charges were collected in the name of water but used for other purposes (such as for partying and administrative expenses). Moreover, the water charges that farmers actually did pay were calculated in terms of the land area irrigated rather than by the volume of water used. Farmers thus had no incentive to use water efficiently.

The authorities and accountabilities of farmers and public water utility were not clear. Farmers viewed the OandM of this utility as very expensive. As farmers did not recognize their responsibility within the public water utility, there was no effective mechanism to ensure an accountability system for efficient water use. Thus OandM was generally inadequate since the maintenance resources allocated by the central and provincial government did frequently not match with the OandM needs. Further, the central government efforts at decentralization and reducing central investment resources had diminished the ability of the Ministry of Water Resources (MWR) to systematically guide and influence a comprehensive water resource development policy.

Distribution of irrigation water between the head and tail ends of the system was also inequitable. In such a situation, the farmers often conspired against one another to get better access to water, preventing them from mutual intervention and interaction for a better form of irrigation and drainage management and decisions-making.

Institutionally, such an organization framework did not provide opportunities and incentives to the farmers for their direct participation. Most of the medium and large irrigation scheme's management was fragmented and dispersed. As a consequence, farmers' participation in system operation and decision-making process was limited, resulting in low system efficiencies averaging 30%-40%, massive waste of water, and low productivity of water used.

Environmentally, a large part of the cultivatable land deteriorated through water logging and soil salinization due to ineffective drainage control for the rising water tables. Further, uncontrolled construction of tube wells prompted by government subsidies had led to over-exploitation of groundwater, falling water tables, and land subsidence.

Investment and maintenance on farm facilities (formerly a communal responsibility during the slack winter season) were replaced by the household responsibility system in reference to a self-managed cooperative accountability. The change led to a situation of self-seeking practice as the households tended to look after their own individual contractual interests.

No systematic institutional and legal framework was in place to handle competing water demands. A water requirement for the growing demand of municipalities and industrial areas was not met adequately and these areas were eyeing farmers' institutionally weak irrigated agricultural sector, the main water consumer.

The severity of constraints and problems of irrigation increases as the population grows and the economy becomes more market-oriented. A Chinese Five Year Plan took note of the severity. The importance of comprehensive water resources management was well recognized and put as a priority issue at the policy level.

The World Bank appraisal and assessment of irrigation component of Yangtze Basin Water Resources Project found that China was always effortful to address and resolve the irrigation management issues at the local level. Accordingly, it adopted financial, administrative, and technical measures for the project. But the extent and nature of the issues did not only ask for more cost-effective and accountable use of the scarce government resources, but also for farmers' direct participation and resource utilization in a way that was comparatively advantageous to promote the adaptability, effectiveness, and efficiency of the irrigation system[3].

The Bank's appraisal and assessment of China's irrigation administration derived inspiration and lessons from i) the farmers' self-managed irrigation development program that the Bank had executed in Nepal (1989-1993); ii) Mexico government's irrigation management transfer program implemented in 1989-1994; and iii) China's own historical indigenous irrigation management practices. In each of these appraisals and assessments, benefits were recorded in

[3] World Bank. 1994. "A Draft Plan on Establishment of Self-financing Irrigation Districts, China – Yangtze Basin Water Resources Project,];" a lso World Bank, 1995. "Yangtze Basin Water Resources Project, Staff Appraisal Report." Reidinger, R, 2000. Irrigation in China's Agriculture: Institutional Challenges. Second World Water Forum. 17-22 March and published in Friendship, A Journal of China Study Center, Nepal: December 2000.

terms of i) farmers' inclusive participation through formation/strengthening of their own water user association (WUA); ii) accountability and cost-effectiveness of WUA in irrigation management tasks (water allocation, distribution, irrigation operation and maintenance, irrigation fee determination and collection, organizational development); iii) reduced irrigation cost for both farmers and local government; iv) reduced water related-conflict at the local level due to equity in water distribution and resource mobilization; and v) diversification and adaptability in resource mobilization, use, and maximization. The most basic and critical element in these successful programs and practices was farmers' own organization that owned and took responsibility for efficient and effective irrigation within the jurisdiction of their organization.

3. Irrigation Management Reform Strategy

Taking into consideration the successful international initiatives and China's own good indigenous irrigation practices, a new irrigation management reform strategy called self-financing irrigation and drainage development (SIDD) program was planned to serve China's needs. SIDD was defined as "an establishment of sustainable resource-based system that enables farmers to institutionally assume greater responsibilities for and control of operation, maintenance, and management of irrigation infrastructure and services at the local level." It was made a component of the Yangtze River Water Resource Project in China's Hubei and Hunan provinces, prepared and funded by the world Bank.

As an irrigation management system, SIDD was structured in two integrated parts: WUA operated as the farmers' own water use organizations, taking care of the lower distribution network on the ground. The second was a water supplier (WS-a public utility, authority or corporation) supplying water to the WUA from an outlet in the canal system. Both parts would treat water as economic goods playing the role of a commodity and reflecting the buy-and-sale nature of a market. In such an integral form, however, neither WS nor WUA would be a profit-oriented entity but would function as a non-profit social productive service for farmers as end users of the irrigation water. By virtue of its nature, SIDD model would be characterized by two meaningful transfer processes: transfer of local irrigation management from government to farmers themselves, and transfer of the economic foundation of local irrigation system from a planned command economy to market economy.

In the SIDD areas, WUAs directly purchased water from the WS in terms of the cubic meters of water used. Usually, WS delivers and measures water volumetrically at the WUA head gates/outlet in the presence of the WUA

representative. Water deliveries at the WUA by the WS were governed by the water sales agreement between the parties regulated by their contractual obligation. The obligation often specified the rights and responsibilities of both. Since water deliveries were charged volumetrically, WUA farmers had a strong incentive to use water more efficiently and reduce waste. WUAs collected water charges from their member farmers and bought water from the WS on behalf of their members based on water demand. WUAs, with support of the concerned water resources bureau, were registered as legal persons with the local Civil Affairs Department and WS were chartered under the National Company Law. WUA, registered as legal persons with the Civil Affairs Department of the Ministry of Civil Affairs, could independently manage their affairs and contract, lease, or auction the O and M of their canals and facilities if necessary. WUA, coming within the jurisdiction of a Village Committee, would be legal but not independent to conduct any financial or commercial deals with another party.

3.1 Five WUA Principles

The quality of formation and functioning of WUAs very much depended on the following five principles:

i. They are farmers' own organizations, with democratically elected committees and freedom in financial management, and relative operational independence from government on routine activities.
ii. They are based on hydrological boundary as the WUA boundary.
iii. They measure water flows at intakes from the water supplier and pay water fees according to the volume of water supplied.
iv. They deal directly with the water supplier. They collect fees from members and pay directly to the water supplier.
v. They have a reliable water supply and functional distribution system.

3.2 Implementation Challenge and Strategy

Despite the soundness of the SIDD program in terms of its international success and locally adaptable scientific principles, local stakeholders (local political party and provincial government officials, farmers, and officials of central government program such as Comprehensive Agricultural Development) would not be convinced unless they saw how it actually worked on the ground. A section of local leaders also viewed the program as "interference in their sovereign rights." As such, the World Bank Technical Assistance Team (TAT)

for SIDD composed of professionals coming from Nepal[4] adopted a two-pronged strategy to implement the program: i) prepare the local counterpart team for the program and ii) design program implementation procedures. The two-pronged strategy was implemented on the basis of the following tasks:

(a) Observation study of successful international experience and practices;
(b) A pilot approach for WUA development with selection criteria for the pilot WUAs;
(c) Involvement of key stakeholders in the form of project leading group for preparation and implementation of the SIDD plan;
(d) Detailed projections of sub-projects investment, operation, and self-financing costs;
(e) Delineation of hydrologic boundary as the basis for and membership make - up of the WUA organizational structure;
(f) Survey and analysis of farmers' income with and without SIDD;
(g) Management assessment and capability training and orientation on tasks to be undertaken (hydrologic boundary delineation and membership identification, WUA relations with WS, survey and analysis of farmers' characteristics etc.); and
(h) Procedures for Monitoring and Evaluation (ME) of SIDD including specifications of key indicators, baseline data collection, periodic survey, progress monitoring, and impact evaluation.

4. Cases from Hubei Province

4.1 Source of Water for Pilot Area

The head gate of the 3rd Sub-main Canal was located at 36+800 km, that is, the lower part of the 3rd Main Canal. The design discharge of the 3rd Sub-main Canal was 7.7 m^3/sec, with an irrigation area of about 115,000 Mu (15 Mu=1 ha.) and length of 27.4 km. It was completed in 1965. The efficiency of the canal was declining from the very beginning. The capacity of the upper part (19.2 km) of the Sub-main Canal was only 6.0 m^3/s and the lower part (8.2 km) was almost out of service because of siltation and damage of canal banks.

The 3rd Sub-main Canal was run by Liuji Management Section (LMS), the WS, of the 3rd Main Canal Management Division (TMCMD). Under LMS there

[4] This team of the World Bank professionals was supplemented by Chinese experts. Notable among them was Mr. Liu Hubin, senior engineer and former Standing Deputy Director, Project Management Office for Yangtze River Basin Water Resources Project. Liu assisted the team immensely with his insights, knowledge, and experience of irrigation in central China.

were 5 distribution groups with 2-3 farmers employed by each group and 12 for all the groups. The annual wage of each employee was 1080 Yuan (8 Yuan=1 USD). LMS had 6 permanent staff. The annual amount of water distributed by LMS was 10,000,000 – 12,000,000 m^3, total water charge was 140,000 –150,000 Yuan from which 40,000 – 50,000 Yuan was for LMS. The annual operational cost of LMS was 80,000 – 100,000 Yuan.

The Jingji Reservoir, a medium-sized reservoir, supplied irrigation water for the 3rd Main Canal area. While the total capacity of the reservoir was 17,700,000 m^3, the effective capacity was 9,600,000 m^3. The design irrigation area was 560,000 Mu. The actual irrigated area was not more than half of the design irrigation area. The number of staff employed by the Jingji Reservoir Management Division (JRMD) was 26, among which six performed the irrigation management tasks and others were engaged in Jingmen Municipality works.

4.2 The First Hongmiao WUA in Hubei Province

The Hongmiao WUA, the first WUA established on 16 June 1995 in the Zhanghe irrigation area[5] under the leadership of Provincial Project Management Office (PPMO), was the first pilot project for SIDD program undertaken in a learning-by-doing method. It covered the Hongmiao branch canal of Zhanghe irrigation area of the 3rd Main Canal in Jingmen Municipality. The branch canal was 4.9 km long, with two laterals of 3.2 km long. The Zhanghe irrigation system, a gravity multi-functional irrigation system/(flood control, electricity generation, water supply, and irrigation) was fed by the Zhanghe reservoir. The Hongmiao branch irrigated an area of 5200 Mu, covering 525 water user households of 19 villager groups in three villages under two townships. It was constructed in 1965, with a designed capacity of 1.0 m^3/s and designed irrigation area of 7950 Mu. The level above the intake canal was managed by different villages. Since there was no unified and effective water management organization, each village only considered its own needs, deteriorating the irrigation system.

Hongmiao Branch Canal water user organization had two tiers. The 525 user households in the area elected 26 representatives for a WUA Representative Assembly. The WUA Representative Assembly elected 3 WUA Executive Committee members. They discussed and worked out a WUA Charter and related regulations and established a WUA accounting system. At the lower level, the irrigation area was divided into five water user groups based on

[5] The formation of the first WUA in the Hongmiao Branch was celebrated in a public program attended by all senior local leaders and a large number of people. The local news papers acclaimed the event with the comment that the formation of first WUA, an exercise in direct rural democracy based on scientific hydrological principle, was a historic event perhaps only second to the Founding of the People's Republic of China in 1949.

hydrologic boundaries. Each one of these groups had one chief representative for the organizational tasks.

In the initial stage of pilot experimentation, satisfactory achievements for further demonstration of pilot experimentation in local context were promising. Continuous support from the municipal government of Jingmen city encouraged half dozen of WS staff to get integrated with TAT in a learning-by-doing mode. The staff were exposed to the SIDD concept, principles, and procedures, and relevant international experience. The commitment of the municipal government and dedication of staff to realize the project's SIDD objective, especially relating to WUAs, was reflected in their formulation of a draft document entitled "Legal Measures for WUA Management. This document was the first enabling instrument in the successful establishment of the SIDD.

4.3 Yugang WUA

The accomplishment of South-South learning was right away extended to Yugang WUA in Shayang County in the 3rd Main Canal in Zhanghe Irrigation area. The WS staff demonstrated their ability to work with farmers and farmers in turn showed their ability to get organized around a WUA according to the WUA principles. Farmers were aware that they were being mobilized through WUAs for their own benefit. Such mobilization also brought about new impetus and fresh air to local village routine works. Villagers felt happy with the WUAs as an "organized hand" helping in dealing with irrigation matters and local systems maintenance, with a better opportunity for diversified income generating activities[6].

Farmers elected WUA's key office bearers. They decided the canal maintenance and improvement plan, water use plan, and financial and human resources needs through their assembly of representatives of the 84 off-takes within its hydrologic jurisdiction. They invited village committee leaders in their meetings. WUA mobilized financial and labor resources from farmers equitably and on a no-profit-no-loss basis.

Yugang WUA covered 15,000 Mu of farmland and annually paid Yuan 100,000 as water charge. Water charge included a basic fee (to be paid by all water users irrespective of water supply) of 2 kg (rice)/mu and 3.5 kg/100 cm for volumetric supply of water. It added 3 to 5 percent service fee on water charge to meet its OandM costs. The institution of WUA had assured equal treatment to all member farmers in the WUA including the tail-end farmers. They solved problems of internal water conflict and dispute by establishing penalty system. Doing this relieved the village committee and township government, the lowest

[6] Pradhan, P. and U. Gautam. 2002. *Water Users Associations towards Diversified Activities,* in Prachanda Pradhan and Upendra Gautam (e ds.), Farmer Managed Irrigation Systems in the Changed Context. Proceedings of the International Seminar. Kathmandu, Nepal: 18-19 April.

level local government unit, of water conflicts and disputes in the area. Formation of WUAs also increased water conveyance efficiency in the canal and assured better yields (for example, paddy yield was increased by 150 kg/mu on an average). WUA had replaced 168 water guards (two each in one off-take area) by eight staff. Thus, it had become more effective in labor use. About 25% of saved labor were engaged in industrial and construction services in the neighborhood. Major works were started with the rehabilitation of the old canal along with the World Bank's structural improvement works after the formation of WUA. This resulted in increased water flow efficiency from 1.5 to 2.0 cm/s in the lateral canal, which was operated and maintained by WUA.

The overall institutional development impact that WUAs made was substantial. WUA also played an effective role in developing self-management culture at the local level. It, however, also gave farmers a new confidence and an alternative mechanism that helped them to decide for themselves on matters that fundamentally affected their livelihood on a day-to-day basis. In most cases, WUA and village took up issues to tackle in village life. This meant they were not competitive but actually cooperating with each other for diversified use of saved labor in construction and industry, saving water for higher value use, and increasing per unit productivity of both the water and labor used. This new irrigation management situation won support also from the local government units and village committees as WUA-managed water substantially reduced water-related conflict. This led to ensuring peaceful relations between the farmers within the WUA area contributing to social stability, the topmost concern of the local political leadership. The WUA impact was remarkable especially in view of the "suspicion" that local government units had about WUA at the beginning of the SIDD implementation.

After setting up of WUA, members did an excellent job in both the construction work and the O and M of the system under the leadership of WUA. For the situation before and after WUA, two comparative tables are given below (Tables 1 and 2).

Table 1: Engineering works done by WUA (1995-1997)

Contents	Quantity
1. Farmers' labor input	More than 30,000
2. Earth work finished	250,000 m^3
3. Canal lining finished	1.3 km
4. Improvement in branch canal capacity	from 0.5 m^3 (before WUA) to 1.5 m^3 (after WUA)
5. Improvement in lateral canal capacity	from 0.3 m^3 (before WUA) to 0.8 m^3 (after WUA)
6. Road on the dike/bank	5m wide, 4.9 km long
7. Structures	1119 (including gates, culverts, check gate, and bridges)

Table 2: Comparative situation before and after WUA

Contents	Comparison 'Before' and 'After' WUA		Remarks
	'Before' WUA	'After' WUA	
1. Number of labor to guard water	2,040 labor/year	340 labor/year	Saved 60 yuan/ha
2. Irrigation water saved	6,450 m^3/ha	5,000 m^3/ha	Saved 22% of water
3. Increment in agriculture production.	11,250 kg/ha (two crops of paddy and wheat). The ratio of output to input is 161 %.	13,095 kg/ha (two crops of paddy and wheat). The ratio of output to input is 227%	Grain production gain by 1845 kg/ha, of which the gain part due to improvement of irrigation is 738 kg/ha.
4. Water charges and equity	Water charge for head end was 45-75 Yuan/ha and that for tail end was 300 Yuan/ha.	Water charge for the head end was 195 Yuan/ha and that for tail end was 262 Yuan/ha for the year.	
5. Conflicts	A lot of conflicts over disputes over water, blocking canal etc.	Smooth irrigation order, no more conflict about using water.	
6. Condition of irrigation facilities	A lot of damage to irrigation facilities. Of the original 32 structures, only a few were left.	Repaired and newly constructed more than 100 structures; O and M agreements signed between WUA and WUG; Irrigation facilities in good shape.	
7. Involvement of township and village leaders	A number of leaders had to go to the field to solve conflicts during irrigation season.	Two years after WUA, there was no need for leaders to go to the field during irrigation season	
8. Reduced middle links, foundation laid	5-6 middle links existed in the process of water	Water charge directly paid to water supply organization; both	

Contents	Comparison 'Before' and 'After' WUA		Remarks
	'Before' WUA	'After' WUA	
for independent operation of SIDD	charge collection. Farmer had to pay more than they needed.	farmers and water supply organization feel satisfied.	

Source: World Bank, 2002; Implementation Completion Report, p.39.

5. Conclusion

Improvement measures were to be continuously identified and incorporated in the SIDD WUA plan to address the lessons learned and instil new dynamism in WUA development. The SIDD must be an adaptive mechanism[7] that is able to show how it effectively addresses ecological and social issues so that water resource-related line agencies continue to regulate support to SIDD after the project. A permanent support system is very important because SIDD has already come out of the "piloting" stage and has entered a scaled up regular rural management reform program stage. Recently it was estimated that some 50,000 WUAs have been formed in several provinces, autonomous regions, and municipalities of China, covering about one-third of China's total irrigated area[8].

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[7] Reidinger, R. 2011. *Communication of Richard Reidinger to Upendra Gautam.* It states, "…. Of late, they have been instrumental in "Mainstreaming of Climate Change Adaptation into Irrigated Agriculture Project,' which were attached to the huge Irrigated Agricultural Intensification III Project or IAIL3 just closed at the end of 2010. WUAs have become a key part of both IAIL3 in terms of providing a primary mechanism to teach the farmers about climate change adaptation as related to irrigation actions the farmers can take to mitigate climate change impacts, etc. One of the actions taken by farmers with the WUAs under the project was to change crop varieties. ….To compensate for warming temperatures, China has recently been using a little trick … that might also work in Nepal. They have been introducing varieties from northern areas into southern areas (as well as breeding for drought resistance). This type of varietals change is relatively easy and would save the plant breeders a lot of time and effort". 27 April and 23 May. Also, Liping, J. 2011. *How to combat water scarcity in China.* http://comment.chinadaily.com.cn/ articlecmt.shtml. China Daily. 3 March.

[8] Reidinger, R. 2011. *Communication of Richard Reidinger to Upendra Gautam.* It states, "….In 2009 there were some 50,000 WUAs in China, and they cover about a third of the irrigated area. …About 20,000 are registered and therefore have independent legal status. Only the registered WUAs can own property (i.e, their irrigation facilities), have a bank account, sign contracts, etc. Most WUAs are established under the village committee, which makes them legal, but they are not independent or able to have the above key rights". 23 May.